Los Lunas Habitat Restoration Project
Progress Report for 2004–2005

Project Number: NMPMC-T-0404-RI

Executive Summary

Due to the construction of silvery minnow egg retention ponds, the Los Lunas Plant Materials Center (LLPMC) was contracted to restore 1.2 miles of the Rio Grande river bank in Los Lunas, New Mexico. The LLPMC planted native vegetation on approximately 16 acres of a disturbed area of the bosque. The LLPMC implemented planting techniques that involved getting the plants' roots or the cut end of the pole cuttings into the soil where subsurface water is naturally present. This technique takes advantage of natural irrigation.

Currently, most of the plants are healthy even though they have not received any supplemental irrigation. However, the plantings were inundated for 50 or more continuous days in May, June and July 2005, killing many of the transplants and pole cuttings. The rate of survival was affected by plant species and container type.

The plantings included four acres of grass and penstemon seeding, 1200 transplants of three shrub species grown in tall pots, 100 New Mexico olive transplants grown in tree pots, 780 cottonwoods pole cuttings, and 865 black willow pole cuttings.

The survival rate of skunkbush sumac transplants grown in tall pots (8%), New Mexico olive transplants grown in tree pots (14 %), and newly planted cottonwood pole cuttings (27%) were severely impacted by the 50 plus days of continuous inundation. The survival rate of transplants of wolfberry grown in tall pots (50%) was also reduced by the inundation. The wolfberry plants that were planted in low areas and were inundated for the longest period of time had typically died. However, survival of second-year planting of cottonwood pole cuttings (76%) and New Mexico olive grown in tall pots (93 %) was not affected by the 50 plus days of continuous inundation. Survival of the newly planted black willow pole cuttings (67%) did not seem to affected by inundation if they were planted in sandy top soils. When planted on sandy top soils, nearly 100 % of the plants survived. On clay top soils, most had died.

Moist soil along riparian areas in the arid southwest is very conducive to growing vegetation, including competitive weeds species. Once the soil of a riparian area is disturbed, it is common for annual and perennial weeds to establish quickly. New plantings and seedings will find it difficult to compete with fast-growing weeds for light, water, and nutrients. Applying a surface layer 4-6 inches of wood chips will reduce weed emergence and allow desired plants to grow. Surface mulch was not applied in this planting, and resulted in a continual application of weed control methods to protect the desired plants.

Currently, the four-acre seeding on the high-flow berm has not become established. It is competing with a dense population of annual weeds. The LLPMC will continue mowing this seeding to reduce the weed competition.

In addition, dense stands of salt cedar seedlings and salt cedar root sprouts are becoming established on the planting areas along the high-flow berm. These stands of salt cedar need to be controlled while they are small and can be killed easily by herbicide applications. If the salt cedar stands are not controlled, they will be more competitive and reduce the density of the desired vegetation.

Introduction

The USDA-NRCS Los Lunas Plant Materials Center (LLPMC) participated in an interagency project designed to restore the hydrology of an area of the Rio Grande in Los Lunas to its natural condition where spring overbank flooding occurs. In an effort to protect the survival of the Silvery Minnow, egg retention ponds were constructed inside a 1.2 mile high flow channel on the river. In the process of building these structures, some of the native and non-native vegetation had to be cleared away. To restore this area to its natural vegetative state, the LLPMC implemented some unique planting methods which will require little or no irrigation. These planting methods were either developed or refined by the LLPMC, and they were used on this project to measure their effectiveness.

Developing a successful transplanting system that requires minimal follow-up irrigation is critical for bosque restoration in the droughty Southwest. These areas receive less than 10 inches of annual precipitation. The selection of tall pots (containers 30-inches in length and 4-inches in diameter) coupled with embedded irrigation tubes (40-inches in length and 1-inch in diameter) were tested at this site. Pole cuttings of cotton woods and western black willows were also tested. Both planting systems rely on getting roots or pole cuttings into the soil where subsurface water is present to provide the irrigation needs for the plants.

The participants in this project consisted of the Los Lunas Plant Materials Center (LLPMC), the Albuquerque District of the U.S. Army Corps of Engineers, the Albuquerque office of the U.S. Bureau of Reclamation (USBR), and the Middle Grande Conservancy District (MRGCD).

Background

In the area of the minnow ponds, the cottonwood gallery was destroyed in a wildfire in the spring of 2000. The scorched, 50-foot mature cottonwood trees appeared to be dead, but by late summer of 2000 they were starting to re-sprout at their base. In order to start the construction of the egg retention ponds in 2002, all of the wood debris had to be removed.

At the request of the LLPMC, the fine branches of the cottonwoods and small trees were chipped and transported to an off-site location. Traditionally the wood chips are used as a mulching layer and spread on the planting site, but the LLPMC thought it would be easier to establish cottonwood pole cuttings, shrub transplants, and grass seedings if the mineral soil was exposed and not covered by a layer of mulch. This would prove to be a costly mistake because of the prolific weed emergence as described in the results section of this document. The larger material, such as the main stems of the mature trees, were also removed and transported to an off-site location. Some standing dead trees were left intact to provide for woodpecker and raptor habitat.

Planting Preparation and Installation

The planting area consisted of two sites totaling approximately 16 acres and 1.2 miles in length (Figure 1). There are approximately eight acres along the MRGCD drain ditch road and approximately eight acres along the high-flow berm adjacent to the Rio Grande. The MRGCD requested us to leave a 30-foot open area along the berm for access to the site.

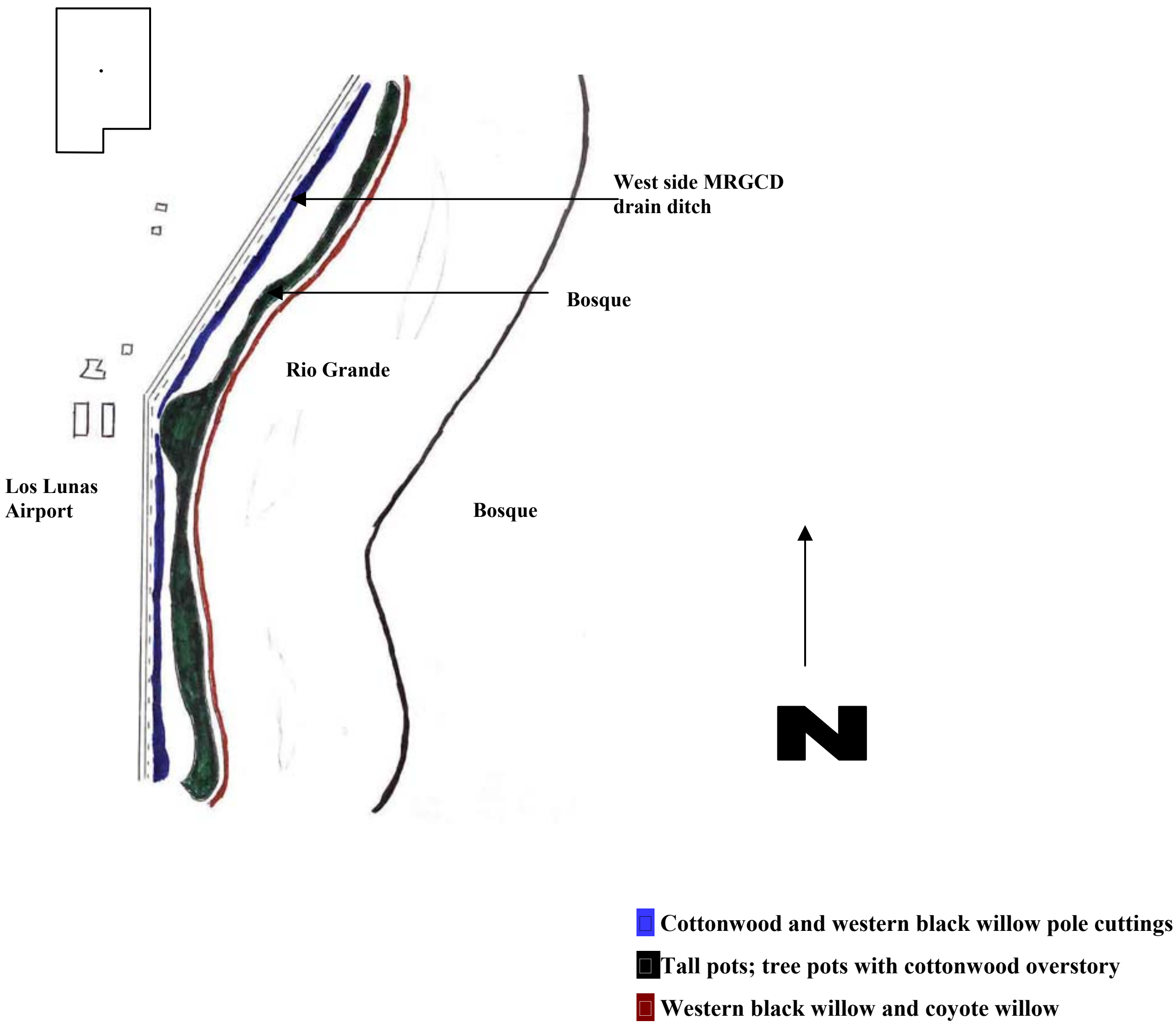

Figure 1: Map detail of the Los Lunas Habitat Restoration Project

April 2004

Location: North of the river access road between the existing bosque and the MRGCD drain ditch road.

The LLPMC staff planted 580 cottonwood (*Populus deltoides*) pole cuttings and 20 western black willow (*Salix gooddingii)* pole cuttings. The original source of the poles was taken from the Bosque del Apache Wildlife Refuge, but the poles that were cut and planted were grown and harvested from production fields at the LLPMC. We prepared the poles by pruning all but two or three terminal branches. The cut poles were then kept hydrated by placing their cut ends in water tanks until they could be planted.

The planting holes were dug using a 65-hp farm tractor with a front-end mounted auger that was 9-inches in diameter and 8-foot in length (see Figure 2). We planted the poles on 15–30 foot centers. After planting the poles we placed a poultry-wire tree guard (5-foot in height and 10-inches in diameter) around each pole to control beaver predation.

Figure 2: Planting cottonwood poles in April 2005

May 2004

By May of 2004, several mature cottonwoods had fallen over the access road that parallels the high-flow berm. The LLPMC staff used chain saws to cut up the debris, and then removed it from the planting site.

May, June, July 2004

Location: 1.2 mile high-flow berm along the river and the access road parallel to the high-flow berm (see map).

To prepare for the seeding, we sprayed this area once in May, once in June, and once in July with the herbicide glyphosate ('Rodeo') at the rate of 1-gallon per acre to control common annual weeds. The site was kept fairly clean with this treatment. To apply the herbicide, we used a 50-hp farm tractor outfitted with a power take off (PTO), 10 ft. boom spray system. The entire seeding area is approximately 4 acres in size.

Because the access road had been driven over regularly by vehicles resulting in compacted soil, we disked the access road that had been sprayed prior to the seeding.

August 2004

During the first week of August 2004, the prepared site was seeded by hand-broadcasting the seed. The seed then was incorporated into the soil by harrowing with a farm tractor which covered the seed with approximately ¼-inch of soil.

The seed mix was composed of sand dropseed (*Sporobolus cryptandrus*), Indian ricegrass (*Achnatherum hymenoides*), alkali sacaton (*Sporobolus airoides*), blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), and narrowleaf penstemon (*Penstemon angustifolius)* (see Table 1).

Table 1: Seed mix for the Los Lunas Restoration Project

Common Name	Scientific Name	% Composition	Seeds/lb	Seeds /sq ft	PLS lbs/acre
Blue grama	*Bouteloua gracilis*	10	825,000	4	0.21
Galleta	*Pleuraphis jamesii*	20	470,000	8	0.74
Indian ricegrass	*Achnatherum hymenoides*	40	141,000	16	4.94
Alkali sacaton	*Sporobolus airoides*	15	1,758,000	6	0.15
Sand dropseed	*Sporobolus cryptandrus*	10	5,298,000	4	0.03
Narrowleaf penstemon	*Penstemon angustifolius*	5	313,000	2	0.28

September 2004, July and August 2005

The seeding was mowed with a brush hog once in September 2004, once in July 2005, and once again in August 2005 to control annual weeds (Figures 3 and 4).

Figure 3: The grass seeding on high flow berm before mowing in July 2005 (looking north). The weeds are mainly Russian thistle and Kochia.

Figure 4: The grass seeding on high-flow berm after mowing in July 2005 (looking south).

November 2004

To prepare the site for the containerized transplants, the soil surface of the planting area, located between the access road along the high flow-berm and the bosque, was scraped with the blade of a small dozer to remove the thick annual weed cover (mainly sunflowers and kochia with some approaching 12-foot in height). The weeds were piled outside the planting areas.

In mid-November, we planted 1,100 tall pots and 100 tree pots in the cleared areas:

- 700 New Mexico Olive (*Forestiera neomexicana*) tall pots
- 100 New Mexico olive tree pots
- 300 wolfberry (*Lycium torreyii*) tall pots
- 100 skunkbush sumac (*Rhus trilobata*) tall pots

The plants were planted to the depth of subsurface moisture, approximately 3- to 6-feet (Figure 5). Paired plantings of 100 New Mexico olive tall pot and 100 New Mexico olive tree pot transplants were planted within 8-feet from each other to test the effectiveness of the pot size on plant survival. An irrigation tube measuring 40-inches long and 1-inch in diameter was embedded with each transplant for future irrigation treatments. The lower ⅓ portion of the tube was perforated to enhance water dispersion in the root zone of each plant.

Figure 5: Planting New Mexico olive tall pot transplants with sub-irrigation tubes in November 2004.

February 2005 The area between the MRGCD road on the west side of the river, and the bosque north of the pond access was mowed in preparation for the March 2005 planting of cottonwood pole cuttings.

March 2005

In early March, the area was planted with 300 cottonwood pole cuttings. The cuttings were planted on approximately 30–40 foot centers. Each pole had a poultry wire tree guard installed using the same methodology as previously discussed.

April 2005

Location: East side of the high-flow berm

To reduce stream flow velocity protecting the berm, we planted 845 western black willow and 1,425 coyote willow. So that the new planting would not have to be irrigated, both species were planted in 8-foot augured holes that reach subsurface moisture. The coyote willows were planted in group of four willows per hole, about 10 feet from the berm; no tree guards were installed. The western black willows were planted individually along the toe of the berm with tree guards. The areas that had been previously planted with tall pot containerized shrubs were sparsely planted with 110 cottonwood pole cuttings with tree guards to provide an overstory structural component.

Planting Maintenance

The areas planted in tall pot transplants and cottonwood pole cuttings near the river along the west side of the high-flow berm were spot treated once in April with a mixture containing a post-emergent and pre-emergent herbicide which were respectively 2% glyphosate (Roundup at 47.6 %) and 2% pendimethalin (Pendulum at 37.4 %).

In May 2005, only the post-emergent herbicide was applied. In both April and May, glyphosate ('Pondmaster') was applied around the edge of the pond to control mainly sunflower and kochia. By mid-May most of the treated areas were under water due to the rise in groundwater; a consequence of the extremely high flow of the Rio Grande. This high flow of water was due to twice the normal amount of snow-pack in the watershed compounded by extremely warm air temperatures. This area remained under water until mid-July.

When the soil surface dried out enough for a vehicle to enter the site (late July 2005), the perimeters of the tall pot transplants were sprayed with glyphosate (Roundup at 47.6%) to control annual weeds so plants could be located for irrigation and evaluated. Unfortunately, there was no control of annual weed emergence by the pendimethalin which had been previously sprayed. The chemical was probably diluted past the state of effectiveness by the long standing surface water.

As of August 26, 2005, there has been no irrigation treatments applied to any of the plantings. Subsurface moisture at this time was found to be approximately 18 inches below the surface.

The plantings were evaluated for survival August 22–23, 2005. Survival results for the treatments of the parried plot trial were analyzed using the SAS Statistical analysis procedure GLM (see Attachment A).

Results and Discussion

The construction of the silvery minnow egg retention ponds resulted in massive soil surface disturbance. With the mixing of subsurface and surface soil, new weed seed was positioned on the surface ready to germinate and establish with the addition of water. Because of the high flows of the Rio Grande, water was ponded on the soil surface for more than 50 days (Figure 6). In addition to providing anaerobic conditions for the planted shrubs and pole cuttings, a surplus supply of water was available for weeds to germinate, establish and grow. Consequently, during the entire period of this planting, the LLPMC has had to control weeds using both mechanical and chemical treatments. Otherwise the planting easily could fail because of the blanket shading and other impacts that would occur.

Figure 6: A typical inundated area of the planting with New Mexico olive tall pot transplants in the foreground in June of 2005.

Leaving a 4- to 6- inch chip layer on the soil surface would have reduced the continued need for weed control. A mulch layer similar to this was left where the mulch piles once stood and after two years it is still controlling weed emergence (Figure 7). These sites are highly productive because of the presence of surface water and need to be protected from annual and new perennial weed emergence once they are disturbed.

Figure 7: The second growing season for cottonwood pole cuttings planted at the side between the existing bosque and the MRGCD drain ditch road covered with a 4- to 6-inch surface mulch layer of wood chips. In the background where no surface mulching occurred, exists a dense ground cover of annual weeds in August 2005.

The berm grass and penstemon seeding began emerging in late August of 2004 after several rainstorms. Emerging seedlings of galleta and Indian ricegrass were the most common (Figure 8). Desert salt grass was also volunteering on the site. However, the seed bed was dominated by high densities of Russian thistle (*Salsola kali*) and kochia (*Kochia scoparia*) seedlings. Both plants are more competitive for light, water, and nutrients than grass seedlings. In retrospect, the site should have had weed control applied for at least two years prior to seeding to reduce this competition. As of August 2005, the berm is still dominated by weeds with some grass plants present. Unlike the other species seeded, New Indian ricegrass and penstemon seedlings will continue to emerge for the next two years.

Figure 8: Grass emergence on the berm seeding in September 2004. The grass in the foreground is desert saltgrass, other grasses are mainly galleta and Indian ricegrass.

Of the 600 pole cuttings planted in the April of 2004 (580 cottonwood and 20 western black willow), only 384 cottonwood and 17 western black willow were found, approximately 67 percent of the plants (Figure 9). The others are in a dense forest of 10–12 foot kochia, sunflowers, coyote willow and other vegetation. Of the plants that were located, the cottonwoods averaged 84 percent survival and the western black willow averaged 76 percent survival. The 50 days of inundation did not seem to have an effect on the survival of the poles that had already rooted one year earlier.

Figure 9: Cottowoods poles cuttings in their second year planted along the MRGCD drain ditch road in August 2005.

However, of the 410 cottonwood pole cuttings planted in March and April 2005, the survival rate averaged only 27 percent. The trees were affected by the 50 day plus inundation which occurred from May to July of 2005. The pole cuttings leafed out in May as they typically do, but they began to show signs of chlorosis by mid-June, and by July (Figure 10) they had dropped their leaves. Those plants that did survive were located on slightly higher ground within the planting. Similar survival results occurred on a new planting of cottonwood poles about 15 miles south of this planting. This similar planting was also inundated, and most of these pole cuttings also died except for those that were planted on higher ground.

Figure 10: In July 2005 three months after planting, these cottonwood pole cuttings had dropped their leaves and are probably dead.

Survival of the western black willow planted on the toe of the berm averaged 53 percent as a consequence of inundation (Figure 11). Those planted in sandy top soil seemed to have a higher survival rate (Figure 12). Their were areas within the planting that had 30 or more consecutive dead willows that seemed to correlate to clay soil surface texture which may provide less air for root respiration under saturated conditions. Traditionally, survival averages above 70 percent when conditions are ideal and the plants are not inundated. Survival of the coyote willow averaged about 75 percent even though they were planted in a slightly lower area than the western black willow (Figure 13). They appear to display a better tolerance to inundation than the western black willow. Some of the coyote willows were damaged by beaver. However the stems that were cut all had new growth. The western black willows with the beaver guards were left intact.

Figure 11: Western black willow pole cuttings planted on the toe of the high-flow berm are inundated in June 2005.

Figure 12: Western black willow pole cuttings five months after planting on sandy topsoil in August 2005.

Of the 700 New Mexico olive tall pot transplants, 609 plants were found. The plants averaged a 93% survival rate (Figure 14). The inundation did not have a significant impact on New Mexico olive tall pot survival. These plants can tolerate this extended period of inundation.

Figure 13: Coyote willow pole cuttings (center) four months after planting in the high-flow channel in August 2005.

Of the 100 skunkbush sumac that was planted, 90 plants were located. Skunkbush sumac tall pot transplants averaged an 8 percent survival. Every plant that was inundated for the extended period died. Only those plants that were planted on high ground survived.

Of the 300 wolfberry planted, 193 plants were located. Wolfberry tall pot transplants averaged a 51 percent survival. These plants were also impacted by inundation but not as severely as skunkbush sumac.

Figure 14: New Mexico olive tall pot transplants in foreground 8 months after planting in August 2005.

Survival of the New Mexico olive tallpots (89 %) was significantly greater (.0001) than survival of the treepots (14 %) in the paired plot trial (see Figure 15). The tree pot transplants broke dormancy in May and dropped their leaves in June and then died while the soil was still inundated. These plants have smaller root system (10–12 inches in length) compared to the root system of plants grown in tallpots (25–27 inches in length). The larger root systems of plants grown in tall pots may have allowed the plants to tolerate inundation for a longer period of time. The buried stem of the tree pot plants would be less tolerant of inundation.

Figure 15: Survival test of New Mexico olive tall pots (white tubes) compared to New Mexico olive tree pots (red tubes) planted next to each other in paired plots in July 2005.

In addition, dense stands of salt cedar seedlings and salt cedar root sprouts are becoming established on the planting areas along the high-flow berm. These stands of salt cedar need to be controlled while they are small and can be killed easily by herbicide applications. If the salt cedar stands are not controlled, they will be more competitive and reduce the density of the desired vegetation.

Table 2: Los Lunas Habitat Restoration Plantings and Survival Rates

Species/Container Type	November 2004 Planting	April 2004 Planting	Planting Survival Rate	March 2005 Planting	Planting Survival Rate
New Mexico olive tree pot	100		14%		
Skunkbush sumac tall pot	100		8%		
Wolfberry tall pot	300		51%		
Cottonwood pole cuttings		580	84%	410	27%
Western black willow pole cuttings		20	76%	845	53%
Coyote pole cuttings				1,425	
New Mexico olive tall pot		700	93%		

Summary

In summary, the success of the Los Lunas Airport Project was impacted by the following major factors:

- The 50 or more days of inundation had the following effects:
  - No effect on the survival rate of New Mexico olive transplants grown in tall pots and cottonwood pole cuttings in their second year of establishment.
  - Significantly reduced the survival rate of Wolfberry transplants grown in tall-pots, skunkbush sumac transplants grown in tall-pots, New Mexico olive transplants grown in tree-pots, and first-year planted cottonwood pole cuttings.
- Controlling the emergence of competing weeds is critical for the establishment of native vegetation in a newly disturbed riparian ecosystem. Control can be accomplished by applying a surface layer of wood chips 4 to 6 inches in depth.

Attachment 1

The GLM Procedure

Class Level Information

Class	Levels	Values
Pot	2	0 1
Location	76	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76

Number of Observations Read	152
Number of Observations Used	152

13:02 Wednesday, October 19, 2005

The GLM Procedure

Dependent Variable: Survival

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	28.81578947	0.37915512	3.12	<.0001
Error	75	9.12500000	0.12166667		
Corrected Total	151	37.94078947			

R-Square	Coeff Var	Root MSE	Survival Mean
0.759494	67.11233	0.348807	0.519737

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Pot	1	21.37500000	21.37500000	175.68	<.0001
Location	75	7.44078947	0.09921053	0.82	0.8105

13:02 Wednesday, October 19, 2005

The GLM Procedure

Bonferroni (Dunn) t Tests for Survival

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	75
Error Mean Square	0.121667
Critical Value of t	1.99210
Minimum Significant Difference	0.1127

Means with the same letter are not significantly different.

Bon Grouping	Mean	N	Pot
A	0.89474	76	1 tall-pot
B	0.14474	76	0 treepot

* (significantly greater @ alpha .05)